# Department of Defense

## Legacy Resource Management Program

PROJECT 14-764

# Migratory connectivity of At-Risk grassland birds

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# Migratory connectivity of At-Risk grassland birds

## Naval Air Station Patuxent River 2015 Research Report

### Executive Summary

In 2015, the Vermont Center for Ecostudies initiated an innovative grassland bird research project at Naval Air Station Patuxent River and five other military installations. Supported by the DoD Legacy Program, Project 14-764, contract no. W81EWF-4119-9496, this research is designed to elucidate the migratory pathways and wintering grounds of three At-Risk grassland bird species: Grasshopper Sparrow (*Ammodramus savannarum)*, Eastern Meadowlark (*Sturnella magna*), and Upland Sandpiper (*Bartramia longicauda*). Understanding the entire annual cycle of migratory birds offers avenues for sharing the burden of protecting declining populations. Data collected from across the breeding range will provide insight into regional population connectivity, applicable to other installations that support grassland birds. In 2015 we exclusively focused our research efforts on Grasshopper Sparrows, but we will expand our efforts to Eastern Meadowlarks and Upland Sandpipers in 2016.

In attempts to further understand the complete annual cycle of a declining migratory grassland bird, the Grasshopper Sparrow, we attached light-level geolocators to individuals at PAX. Field work commenced on 1 June and lasted to 19 June 2015. In total, we caught 48 individual Grasshopper Sparrow and recaptured one previously banded bird. We deployed 30 geolocators on male Grasshopper Sparrows, and collected blood and feather samples from an additional 18 individuals. We conducted 38 point counts at 19 stations throughout the base and detected a total of 42 species. We also documented all birds detected throughout our daily work and documented those efforts through eBird: a global online avian database.

PAX supports a fairly robust grassland bird population and healthy grasslands. We found that Grasshopper Sparrows were the dominant grassland bird species and were found in high densities throughout the base within open grasslands. We focused primarily on the airfield due to the abundance of Grasshopper Sparrow and ease of access to this area. Eastern Meadowlarks also have a sizable population on base, and as expected we did not detect any Upland Sandpipers. We recommend that PAX maintain their prescribed fire regime, with particular focus on the southeast side of the runway lights to slow the invasion of woody shrubs. Mowing is necessary at PAX to maintain airfield safety, but mowing during June and July likely results in total nest failure in these areas.

## Project Background

The quantity and quality of grassland bird habitat has declined in North America during the last half century, and concurrently, grassland bird population declines have been among the steepest of all North American landbirds. More than 70% of grassland bird species declined significantly between 1966 and 2012, while only 7% have increased. Upland Sandpiper (*Bartramia longicauda*), Grasshopper Sparrow (*Ammodramus savannarum*), and Eastern Meadowlark (*Sturnella magna*) are three At-Risk migratory grassland bird species that commonly occur on military installations supporting substantial grasslands. Populations of Grasshopper Sparrow, a DoD PIF priority bird species, have dropped by 78% in the last 4 decades. Many states, particularly in the Northeast, have listed Grasshopper Sparrows as Threatened or Endangered. Upland Sandpiper populations have decreased substantially in some regions, including parts of the Midwest (IL, WI, MN, and MI), and in NY and other eastern states. It is Endangered, Threatened, or of Special Concern in five of eight Midwestern states and in most eastern states. The U.S. Fish and Wildlife Service considers Upland Sandpiper to be of national conservation concern due to population declines during the last century, and the U.S. Shorebird Conservation Plan lists Upland Sandpiper as a Species of High Concern. Eastern Meadowlark populations have experienced some of the most dramatic declines of grassland bird species. Their long-term population decline has resulted in a loss of 80% of the population since 1966, and this sharp decline has continued unabated even in recent years.

Until now, the understanding of migration and wintering ecology of most migratory songbirds has been extremely difficult, if not intractable. Managers have necessarily managed breeding populations with sparse, if any, knowledge of the limitations imposed on those populations during the rest of the year. Stable isotopes can provide us with clues for some species, but entail many uncertainties. New, powerful tools have emerged that allow researchers to document the daily movements of birds throughout an entire year. For a bird as small as a Grasshopper Sparrow, light-level geolocators can now provide latitude and longitude estimates for each day of its life through an entire year, and larger birds like Eastern Meadowlark can carry GPS geolocators that provide precise (within 500 m) location fixes for up to 30 programmable dates, downloaded via satellite onto a computer. For a species as large as Upland Sandpiper, we now have the capability of accurately tracking (with 500 m resolution) their every move each day, all year, using battery- and solar-powered GPS technology. With this revolutionary advancement, researchers can accurately track a bird during migration and winter, and they can record fine-scale movements in and around breeding areas. By using the latest state-of-the-art technology available, we will not need to recapture Eastern Meadowlarks or Upland Sandpipers to retrieve data.

These technologies will allow us to record wintering areas and to track the timing and routes of an individual bird's migration. We will be able to determine whether these characteristics differ among breeding populations, with implications for where and how a species may be threatened. The data will provide managers with dramatic new insight into the potential limitations and

threats faced by migratory birds throughout their annual cycle, allowing them to forge new partnerships to address these issues.

## Military Mission Benefits

Conservation of natural resources on DoD lands is ultimately necessary to sustain the military training mission by ensuring the long-term availability of training lands (i.e., appropriate habitat conditions). In addition to serving its own mission, conservation fulfills the DoD's obligation, as required by the Migratory Bird Treaty Act, the Readiness Rule, Executive Order 13186, and the Sikes Act, to protect and conserve migratory birds on installations through research, habitat management, partnerships, and education. For all of these reasons, management personnel largely focus on conserving birds and their habitat on installations. Managers can use these resources more efficiently and effectively if there is an understanding of the events that affect migratory birds during their entire life cycle, rather than only during the 3-4 month-long breeding season.

Upland Sandpiper, Grasshopper Sparrow, and Eastern Meadowlark are top DoD priority species in part because they are rare and of high responsibility for DoD. Furthermore, these species are the most likely of grassland bird species to affect or to be in conflict with training activities--further underscoring the need to understand their year-round ecology. We know little about the ecology of these species outside of the breeding season, and therefore the weight of responsibility has fallen entirely on land managers on the breeding grounds, such as DoD, for maintaining populations. Knowledge of the non-breeding ecology of these species will help spread the weight of responsibility to partners, present and future, at migration stopovers and wintering grounds. Addressing threats to these species off the breeding grounds will help the DoD maximize efficacy of breeding season management on installations. Additionally, it will provide opportunities to develop partnerships and enhance cross-cultural outreach with organizations responsible for these same species on migratory and wintering grounds.

By building on grassland bird research previously funded by Legacy, this project provides a rare opportunity to conserve At-Risk species using a "full life cycle" approach. We will complement Legacy-funded work that has assessed the breeding distribution, abundance, productivity, and overall demography of the same grassland bird species on some of the same military airfields (Legacy projects #10-381 and #11-408). Models developed from these breeding season studies have provided an essential means for determining best management practices to benefit birds on installations, but they have not been able to incorporate factors outside of the breeding season that contribute to population viability. Our results will discern where and when, outside of the breeding season, other factors may affect grassland bird populations on installations. Combined with information from Legacy-funded projects on breeding parameters, the data we collect will take the initial, essential steps in ultimately determining the extent to which populations are limited on and outside of military installations. For example, we can begin to address whether

populations that are more productive differ in their migration phenology, routes, or wintering grounds compared to less productive populations.

This project will also benefit from research outside of DOD, further extending the limits of our knowledge, and if DOD desires, maximizing the use of data collected. The Principal Investigator for this Legacy proposal is involved with a project at the University of Wisconsin to develop full life cycle models under different climate change scenarios for other grassland bird species; researchers could use these models as a basis for these three grassland bird species in the future. These novel exercises in full life cycle science and stewardship will serve as templates for other migratory bird species on installations and elsewhere.

The proposed research will directly benefit the six installations included in the study: Joint Base Cape Cod (MA), Patuxent River NAS (MD), Fort Riley (KS), Fort McCoy (WI), Camp Grafton Training Site (ND), and Camp Ripley (MN). In addition, our results will be applicable to other installations across the country. Because our study spans much of the breeding range of the focal species, any installations that support breeding populations of these species may infer the connectivity of migration and wintering grounds with populations breeding on their lands, based on patterns we find. For example, we will discern whether populations breeding in the East migrate and winter in different locations compared to populations in the Midwest. Assuming species behave on this scale, installations in the East can infer where "their" populations are most likely to winter. The list of installations to benefit from our results therefore includes all that support breeding populations of the three focal species. This includes but is not limited to: Hanscom AFB (MA), Fort Devens Army Base (MA), Massachusetts Military Reservation (MA), Warren AFB (WY), Fort Drum (NY), Fort Campbell (KY/TN), McConnell AFB (KS), Grand Forks AFB (ND), Minot AFB (ND), Fort Leavenworth (KS), and Fort Indiantown Gap (PA). These are only the installations that we investigated during our site selection process, a mere subsample of those that will benefit from our study.

Installations that serve as migratory stopovers or wintering areas for these grassland birds will also greatly benefit from knowledge of connectivity between breeding, migratory, and wintering populations. By making connections on a coarse scale between the migration routes and wintering areas of birds with their breeding origin, our study will allow managers to coordinate efforts that will support bird populations during different parts of the life cycle. For example, several Navy installations in Texas host wintering populations of Grasshopper Sparrow and meadowlark spp. Knowledge about where these populations hail from will allow managers to understand where management on the breeding grounds would have the greatest impact on "their" birds. Armed with this insight, installations on the breeding and wintering grounds can work in unison to identify and address the needs unique to the populations they share.

Knowledge of breeding origin and connectivity with wintering grounds will also assist managers at installations supporting migrating bird populations (e.g., Patuxent NAS hosts migrating Upland Sandpipers). By revealing migratory paths, the consistency of migratory stopover use, the length of time spent at stopovers, and the duration and distance of flights before and after a

stopover, we will shed light on how and when different stopover regions are used by migrating birds of different breeding origins. Is a particular installation in the path a commonly used migratory route for all breeding populations or only certain ones? Do the birds stop there prior to or just after a long leg of their migratory flight, suggesting that the food resources may be critical to a successful migration? With the technology we will employ, we will be able to address such questions for the first time.

In this second year (2016) of the project, we will be able to analyze location data from any geolocators that we retrieve from recaptured Grasshopper Sparrows. In 2016 we will also deploy four solar-powered GPS tags on Upland Sandpipers, and almost two dozen battery-powered GPS tags on Upland Sandpipers (22 tags) and Eastern Meadowlarks (20 tags). The battery-powered tags have sufficient battery to store location data for 30 pre-programmed dates, while the solar-powered tags have the ability to last up to 3 years. Based on our observations of grassland birds during the 2015 field season we plan to deploy these tags on Upland Sandpipers and Eastern Meadowlarks at Fort Riley, Fort McCoy, and Joint Base Cape Cod. The other three DoD installations (Camp Grafton, Camp Ripley, and Patuxent River NAS) either lack populations or have very low densities of Upland Sandpipers and Eastern Meadowlarks.

In 2018, we will issue recommendations directly relating to this proposal after we retrieve all data. These recommendations will differ from the typical land use management practices; they will identify where these installation-specific populations may be limited during migration and winter, and thus where land managers may share responsibility. Our recommendations will include a strategy for how and where the DOD, through its alliance with Partners in Flight (PIF), may forge and enhance partnerships on a broad scale in order to maximize positive management impact on grassland bird populations that breed on installations. Installations involved in the project will be advised as to 1) what entities, both military and non-military, they may coordinate with to manage grassland bird populations throughout their life cycle; 2) follow-up research questions or issues that may be helpful for managers; 3) any changes in field protocols that would be advisable or useful for future work using the new technology of geolocators.

Our project will take miniaturized technology to new limits: it will be the first to use light-level geolocators, Argos GPS technology, and PTTs on these grassland bird focal species. We will be able to ask questions that we have never before been able to address, and we will gain insights never before possible. This groundbreaking research will serve as a template for implementing tracking technology for other bird species on military lands throughout the United States. Most importantly, however, the DoD will be involved in a project that will help to transform our way of thinking about how migratory bird species management and partnerships can sustain the military training mission.

## Survey & Capture Methods

Male Grasshopper Sparrows are more vocal, visible, and easier to capture, and have lower inter-annual dispersal rates than female Grasshopper Sparrows. Therefore, we exclusively targeted male Grasshopper Sparrows for light-level geolocator deployment. At PAX we systematically walked transects across the grounds during the first week of June. We focused on the areas of PAX where previous bird surveys had found Grasshopper Sparrows and other grassland bird species (Figure 1). Grasshopper Sparrows prefer areas of extensive grass cover >50 m from woodland edges with little woody vegetation and small areas of exposed ground. Our goal was to identify areas with high concentrations of Grasshopper Sparrows, so that we could deploy geolocators on males in a relatively small area. Marking males in one small area, as opposed to several scattered areas, will reduce the amount of land that we need to search on 2016 to relocate and recapture males wearing geolocators, because male Grasshopper Sparrows often shift their territories between years.

Once we located a singing male sparrow we then set up a 6-m 30mm-mesh nylon mist net on 2-m tall poles (Figure 2). We then placed a small speaker, attached to a smartphone, 1-m away from the center of the net and broadcasted a recording of a male Grasshopper Sparrow song. Male Grasshopper Sparrows are territorial and they perceive the recorded song as an intruding male sparrow. Male sparrows generally flew up to the net and landed on the ground near the speaker. We then quickly approached the bird and encouraged the male to fly into the net. Occasionally male sparrows would fly into the net without encouragement from us. We limited the use of recordings to <5 min with any given male sparrow, and we generally targeted males between 0600 and 1030. This 4.5 hr period corresponds with the timing of copulation in this species, and males became noticeably less aggressive to our recorded intruder song after 1000. We also attempted to capture males in the evening hours (1730-2030), but males showed little interest in our playback during these hours.

Figure 1. *The areas (purple polygons) at PAX where we focused our research efforts for grassland birds in June 2015.*

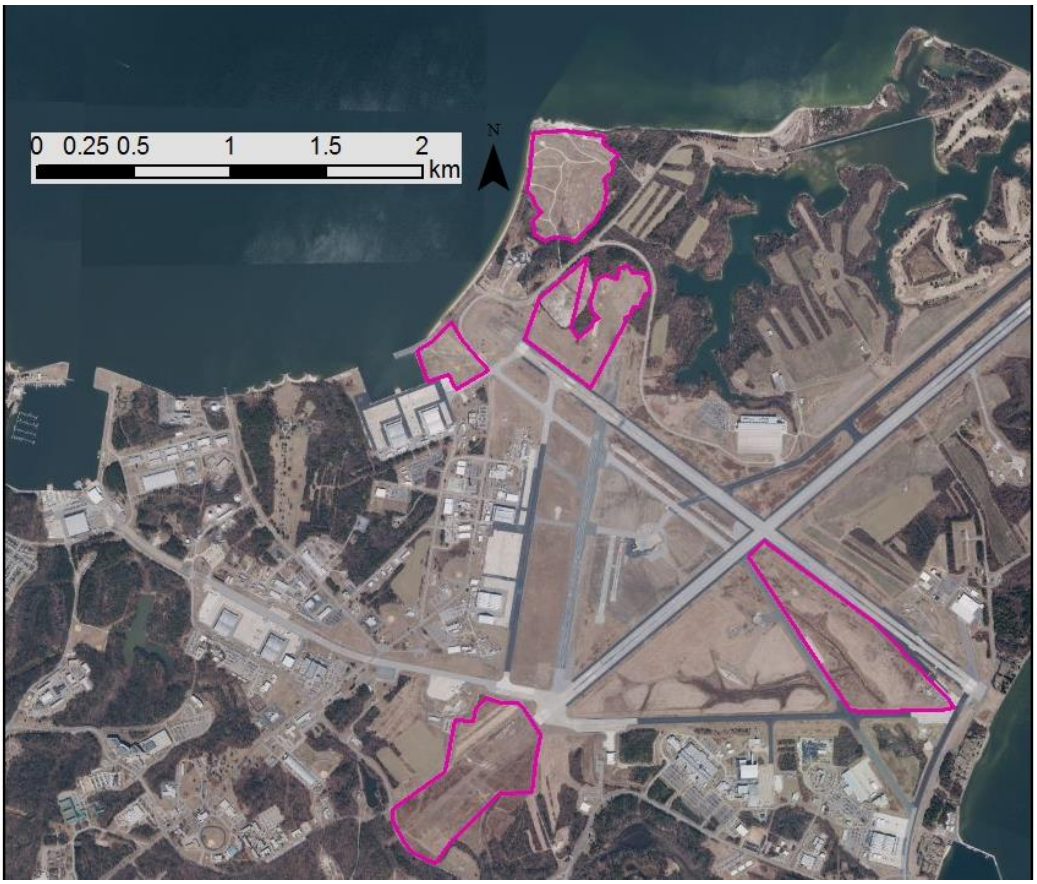


Figure 2. *A male Grasshopper Sparrow perches on a mist net (top panel) looking for the source of the Grasshopper Sparrow song that is coming from our playback equipment. Seconds later we captured him in the mist net after he tried to approach the playback equipment.*

## Banding, Feather, and Blood Sampling

We began banding on 3 June, 2015 and concluded our efforts on 16 June, 2015. For all captured birds we recorded their age, sex, weight, and basic morphological measurements. Handling time was generally less than 10 minutes per bird, and all birds were released unharmed at their capture location. During June, we successfully captured and banded 48 male Grasshopper Sparrows on PAX (Figure 3; Appendix A). In collaboration with other researchers we also sampled a single primary (i.e., wing) feather and a small amount of blood (<100 µl) from birds that did not receive a geolocator. The feather samples will be used by colleagues in a stable isotope analysis to determine the diet of wintering Grasshopper Sparrows, and the blood samples will provide our colleagues with insight into internal parasite loads. We obtained feather and blood samples from 18 birds. One bird was recaptured and had an intact geolocator.

Figure 3: *Capture locations (yellow dots) for all grasshopper sparrows banded on PAX in June, 2015.*


## Geolocator Deployment and Color-Banding

Birds wearing geolocators must be recaptured in 2016 to gain access to geolocator data. To facilitate our future recovery efforts we attached a unique combination of color bands to the legs of a Grasshopper Sparrows fitted with a geolocator. The geolocator units are small (~0.5 g, including the harness; Figure 4) and are difficult to see on a moving bird. Color bands, however, are more visible and in 2016 these color band combos will allow us to quickly key in on birds wearing a geolocator. We made a simple loop harness for the geolocators using an 80.5 mm piece of Stretch Magic bead and jewelry cord (0.7 mm). We passed the material through the geolocator loops, and melted the ends of the cord together using a soldering iron. The resulting fused harnesses are strong, but also flexible so as to accommodate sparrows of varying body sizes.

We only deployed geolocators on birds that weighed ≥17.0 g, so that the geolocator + harness weight did not exceed 3% of body mass. The geolocator harness slipped on over a bird's legs and fit snugly over their hips (Figure 5). Once the geolocator was on the bird we checked the harness fit by measuring the amount of vertical play between the bird's back and the bottom of the geolocator when slight upwards force was applied to the geolocator. We deemed that the harness fit adequately if the play was 1-2 mm. We used a small piece of plastic to smooth the body feathers underneath the harness. Before releasing the bird we made sure that the harness fit securely, and that the wings and legs were free to move unimpeded.

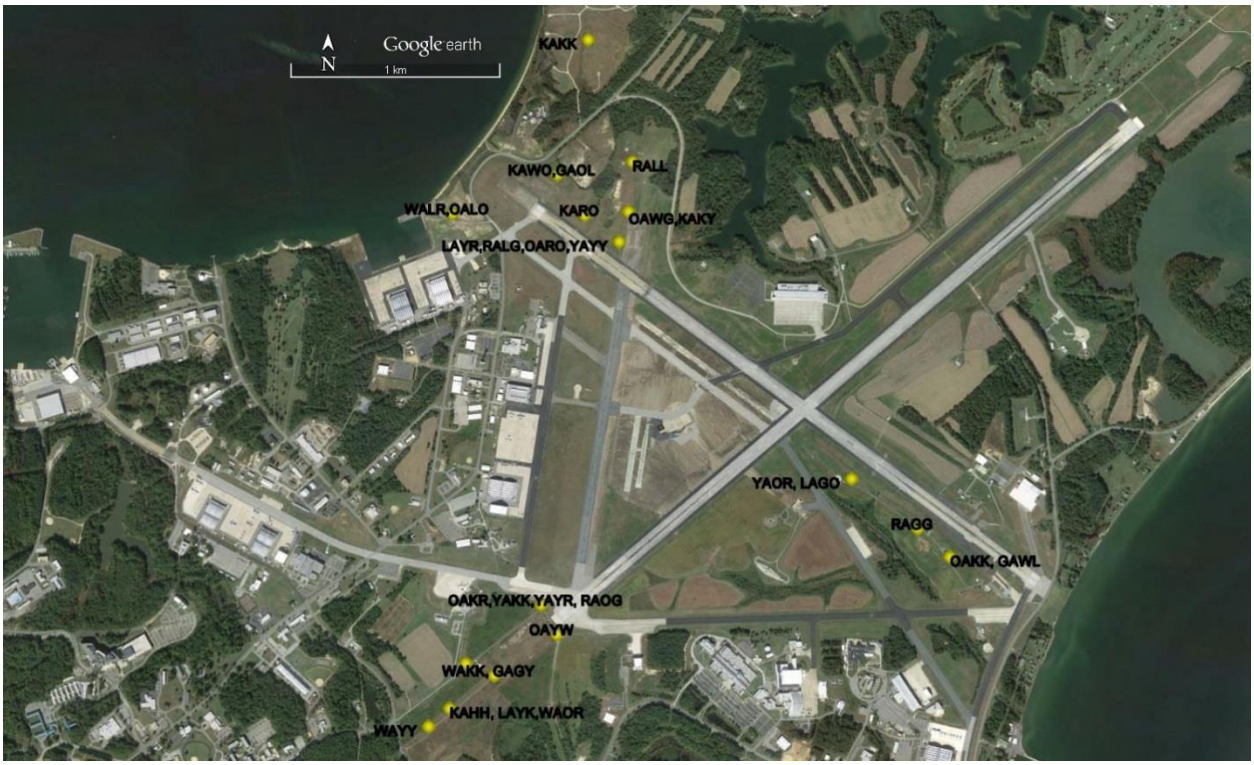
Figure 4. *A geolocator with harness (~0.5 g) prior to deployment on a male Grasshopper Sparrow (visible in background).*

Figure 5. *Grasshopper Sparrow wearing a geolocator (light level stock visible just above the tail).*

We color-banded 30 adult male Grasshopper Sparrows at PAX (Figure 6), and we deployed 30 geolocators (Appendix A). The color band combinations consist of an aluminum band (A) with

three color bands of the following colors: red (R), white (W), blue (L), orange (O), green (G), black (K), violet (V), yellow (Y), and hot pink (H). The color band combinations are read in the following order: right leg top, right leg bottom, left leg top, left leg bottom.

Figure 6: *Locations (yellow dots) of all Grasshopper Sparrows captured and fitted with a geolocator at PAX, MD.*




## Behavioral Observations and Post-deployment Re-sighting

In general, we tried to avoid areas where we had previously banded male Grasshopper Sparrows to avoid accidentally recapturing birds wearing geolocators. We must recapture male Grasshopper Sparrows wearing geolocators in subsequent years to acquire their data; male sparrows become weary of mist nets if we capture them frequently, which could hinder our recapture efforts in 2016. We inadvertently recapture one male Grasshopper Sparrow (LAYK) on the same day that he had been initially captured, but approximately 200 m away from that initial location. This male responded aggressively to our use of playback, and he behaved naturally in regards to the geolocator, which was still fitting well. On approximately six occasions, we re-sighted color-banded male Grasshopper Sparrows, but we could not see the small geolocator stalk though our binoculars.

## eBird Summary

All of our daily observations of birds were entered into eBird (www.ebird.org) [Table 1; Appendix B], which is an online database managed by Cornell University that has become an important resource about bird distribution and abundance for scientists, researchers, and amateur birders. eBird is entirely free and available to anyone with an internet connection, and has dramatically changed the way that the professional and amateur birding communities record and assess information about birds throughout the world. Essentially, an observer enters a checklist of the number of individuals seen of each species that they encounter while birding into eBird (Figure 8). The user plots their location on a map, records information about their effort (e.g., number of hours birded, and distance traveled, if any), and can provide comments about their observations or even upload photos. An expert local reviewer examines each observation to ensure a high level of integrity in the database. In May 2015, for example, users around the world submitted >9.5 million bird observations.

In general, we strived to create a checklist of the bird species that we observed each day on PAX (Table 1), but we also recorded the breeding statuses and interesting behaviors of individuals that we observed. We detected 60 species at PAX and contributed an abundance of data to eBird.org (Appendix B). All of our data and bird sighting information is publicly available on eBird.org, and military personnel can view our data at any time.

Table 1. *Summary of eBird avian observation data from Patuxent River Naval Air Station, June 1 through June 16, 2015.*

| | Jun 1-5 | Jun 6-10 | Jun 11-15 | Jun 16-20 |
|---|---|---|---|---|
| No. of species | 40 | 35 | 44 | 17 |
| No. of individuals | 129 | 117 | 885 | 55 |
| No. of checklists | 3 | 2 | 3 | 1 |

## Point Count Summary

We conducted point count surveys at 19 locations in the general vicinity where we deployed geolocators on male Grasshopper Sparrows (Figure 7). Each point was surveyed twice, by different observers, on different days: 11 and 15 June, 2015. Point count locations were a minimum of 0.25 km apart. Over the course of five minutes a lone observer counted all individual birds that were detected by either sight or sound within an unlimited distance from the point. In practice, however, most individual birds were detected within 100 m of the observer. No audio recordings or decoys of any kind were used to increase the detection of individuals. We made every effort to avoid double-counting individual birds (e.g., a soaring hawk) across multiple point count locations. Each count started immediately as the observer arrived at the point count location, and all points were surveyed between 0530 and 900. In total, 42 bird species were detected during the point counts (Appendix C). The most commonly detected species during point counts were Redwing Blackbird (*Agelaius phoeniceus*) (detected on 63% of point counts), American Crow (*Corvus brachyrhynchos*) (71%), and Grasshopper Sparrow

(95%). Grasshopper Sparrows were abundant throughout PAX (Figure 8), while all grassland birds (including Grasshopper Sparrow, Eastern Meadowlark, Killdeer [*Charadrius vociferus*], Horned Lark [*Eremophila alpestris*], and Dickcissel [*Spiza americana*]) were most abundant at point count stations adjacent to the airfield (Figure 9).

Figure 7. *Point count locations (purple markers) were systematically located within the area of PAX where we deployed geolocators.*

Figure 8. *The mean number of Grasshopper Sparrows detected on a point count in the 100-m area surrounding each point count location at PAX in June, 2015.*

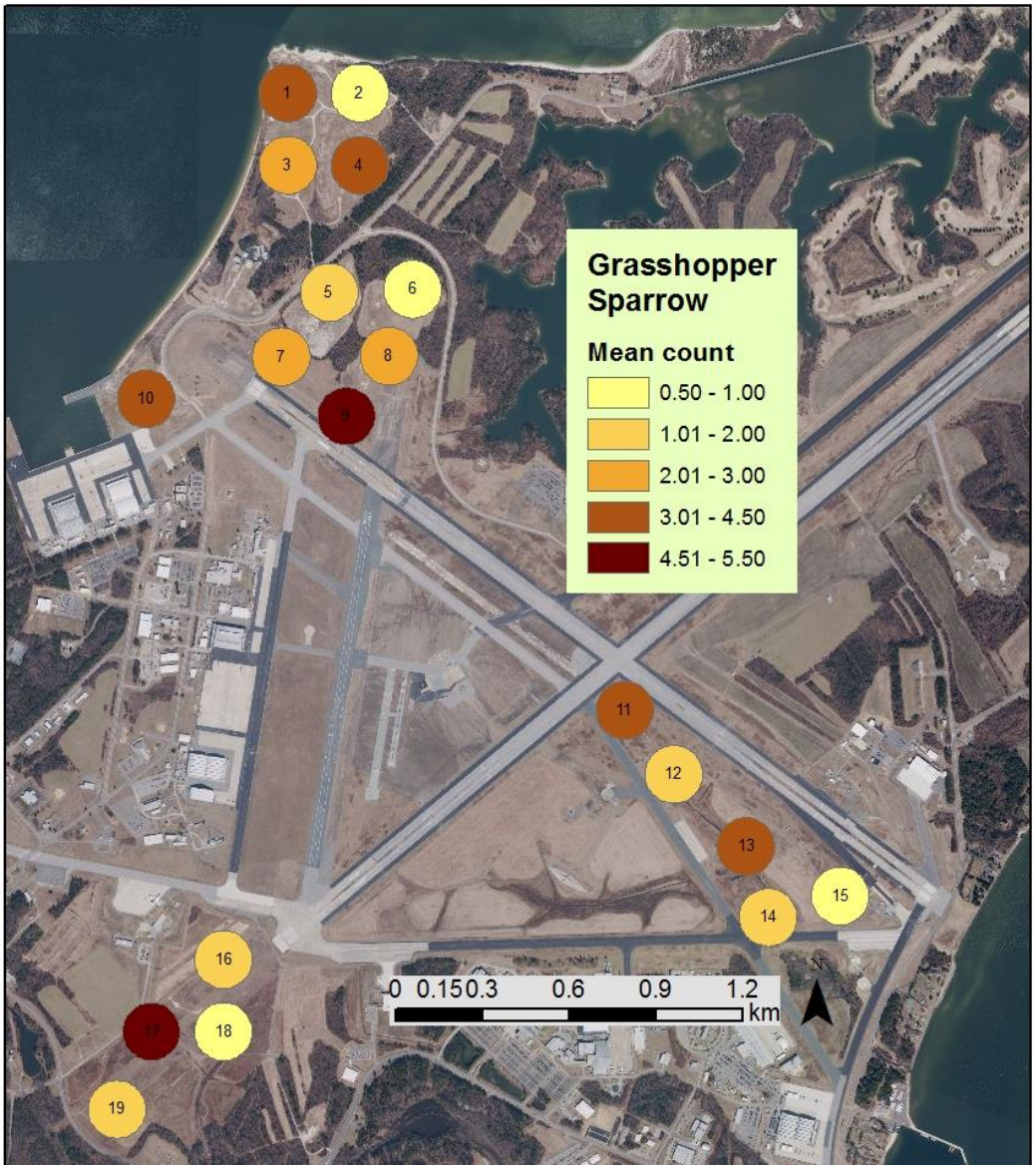
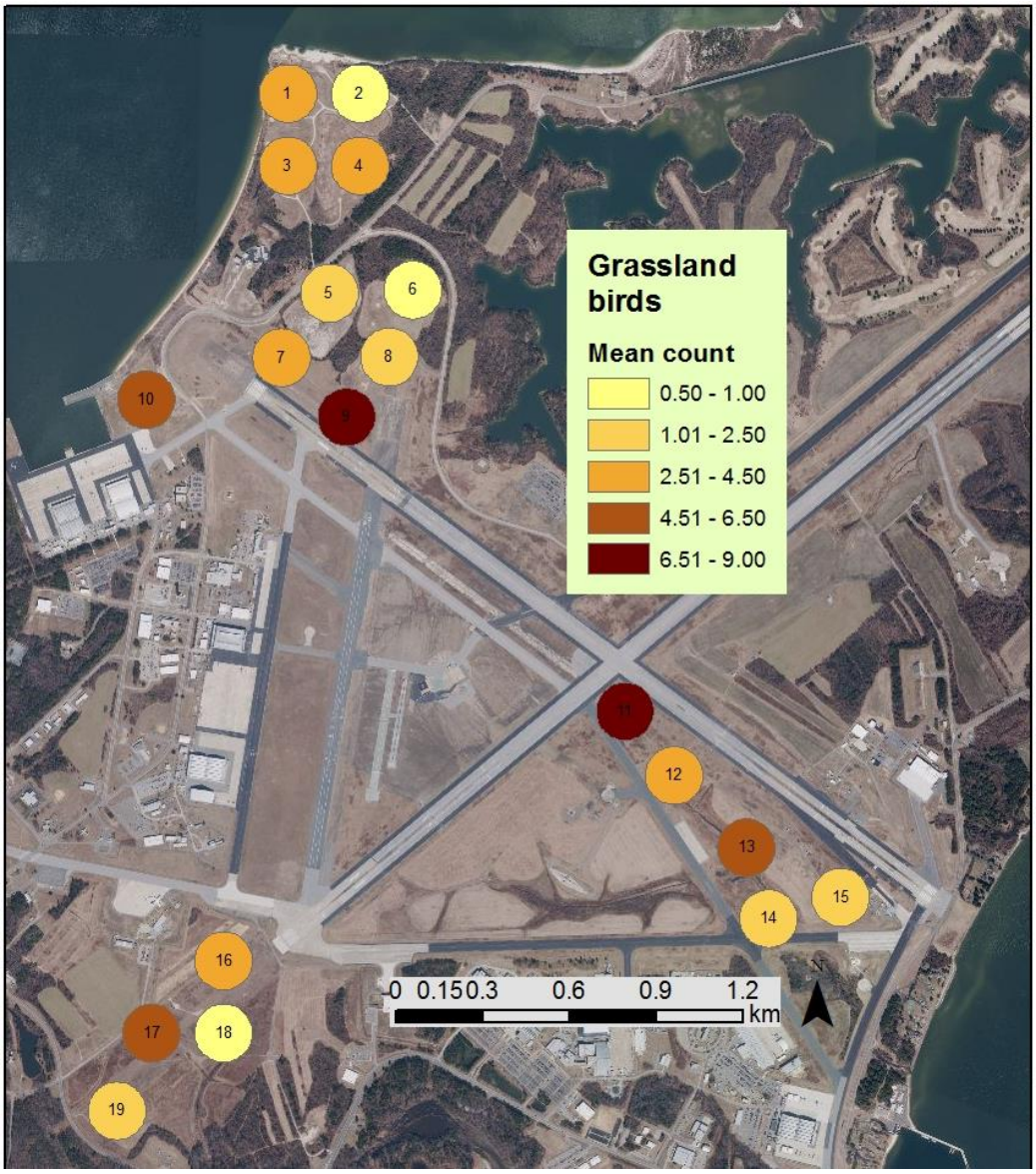


Figure 9. *The color represents the mean number of individual grassland birds (including Grasshopper Sparrow, Eastern Meadowlark, Killdeer [Charadrius vociferus], Horned Lark [Eremophila alpestris], and Dickcissel [Spiza americana]) detected on a point count in the 100-m area surrounding each of the 19 point count locations at PAX, MD.*




## Habitat Management Recommendations

The majority of the grasslands on PAX are well maintained and host several grassland bird species including Grasshopper Sparrows and Eastern Meadowlarks. During our frequent in-person meetings, phone calls, and emails with Kyle Rambo (Conservation Director, PAX) and Jim Swift (Natural Resource Specialist, PAX) we were informed of the management history for grasslands and grassland bird species at PAX. The continuation of a rotational prescribed fire regime, burning individual parcels every 2-3 years, will promote grassland bird populations at

PAX. Prescribed fire promotes grass growth and prevents the invasion of woody shrubs. Particular care should be focused on the southeast side of the runway lights, where dense shrubs are firmly established; if the shrubs are not removed, grassland birds will abandon this section of PAX. If possible mowing should be avoided during the peak breeding season (1 June to 15 July) in order to minimize the mortality of nests and flightless fledglings. We recognize that this poses logistical and safety challenges, particular on the airfield. If mowing is absolutely necessary we recommend mowing occur after an extreme weather event (e.g., rainfall that causes temporarily grassland flooding), when some grassland bird nests will have already failed due to the weather.

## Lessons Learned

Unforeseen events will affect any research project of this size and scope, but for the most part, we were very fortunate and prepared at PAX in 2015. Compared to some of our other partner installations (e.g., Camp Ripley, MN), we had access to very thorough bird data from eBird and Kyle Rambo for PAX. Access to this information had a large and positive effect on the success of our research at PAX. Without access to this information, we would have needed a greater amount of time at PZX to scout for areas with high densities of grassland birds.

Conducting research at PAX is challenging due to the presence of grassland birds along the runways. We found that it was critical to communicate directly in person or over the radio with all parties before making plans to perform research on a section of PAX. We needed an airfield driver training and testing which took one week to complete. During this time, we relied on military personnel to transport us around PAX. In the future, we may try to visit PAX during May to take the driver training ahead of time, but this will be logistically difficult.

## Acknowledgments

Funding and support by the DoD Legacy Program (Project 14-764, contract no. W81EWF-4119-9496), and the assistance of Kyle Rambo (Conservation Director, PAX), Jim Swift (Natural Resource Specialist, PAX), Daniel Inserillo (Field Crew Leader, VCE), Kelsey Pangman (Field Technician, VCE), Emily Grasch (Field Technician, VCE), and Amanda Werrell (Intern, PAX) were instrumental to our success at PAX. Jim Swift guided and escorted us around the base, provided us with a radio, coordinated our efforts with military personnel, and along with Kyle Rambo (our main point of contact for everything) informed us of the locations of grasslands and grassland birds at PAX. Thank you everyone.

Appendix A: Banding data for PAX (June, 2015)

| Capture date | UTMS Easting zone 18 | UTMS Northing zone 18 | Disposition | Band number | Species | Color band combo | Fitted with a geolocator? | Blood sampled? | Feather collected? | Age | Sex |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 6/4/2015 | 375643 | 4237418 | First capture | 222152945 | Grasshopper Sparrow | OAYW | Yes | | | Adult | Male |
| 6/4/2015 | 375568 | 4237555 | First capture | 222152946 | Grasshopper Sparrow | YAKK | Yes | | | Adult | Male |
| 6/4/2015 | 375568 | 4237555 | First capture | 222152947 | Grasshopper Sparrow | YAYR | Yes | | | Adult | Male |
| 6/4/2015 | 375568 | 4237555 | First capture | 222152948 | Grasshopper Sparrow | OAKR | Yes | | | Adult | Male |
| 6/4/2015 | 375420 | 4237589 | First capture | 222152949 | Grasshopper Sparrow | RAOG | Yes | | | Adult | Male |
| 6/4/2015 | 375214 | 4237285 | First capture | 222152950 | Grasshopper Sparrow | LAOL | Yes | | | Adult | Male |
| 6/5/2015 | 375224 | 4237095 | First capture | 222152951 | Grasshopper Sparrow | LAYK | Yes | | | Adult | Male |
| 6/5/2015 | 375224 | 4237095 | First capture | 222152952 | Grasshopper Sparrow | WAOR | Yes | | | Adult | Male |
| 6/5/2015 | 375138 | 4237077 | First capture | 222152953 | Grasshopper Sparrow | KAHH | Yes | | | Adult | Male |
| 6/5/2015 | 375040 | 4236994 | First capture | 222152954 | Grasshopper Sparrow | WAYY | Yes | | | Adult | Male |
| 6/5/2015 | 375294 | 4236949 | First capture | 222152951 | Grasshopper Sparrow | LAYK | Yes | Yes | Yes | Adult | Male |
| 6/5/2015 | 375347 | 4237228 | First capture | 222152955 | Grasshopper Sparrow | WAKK | Yes | | | Adult | Male |
| 6/5/2015 | 375382 | 4237269 | First capture | 222152956 | Grasshopper Sparrow | GAGY | Yes | | | Adult | Male |
| 6/5/2015 | 377494 | 4237770 | First capture | 222152957 | Grasshopper Sparrow | OAKK | Yes | | | Adult | Male |
| 6/5/2015 | 377494 | 4237770 | First capture | 222152958 | Grasshopper Sparrow | GAWL | Yes | | | Adult | Male |
| 6/5/2015 | 377344 | 4237902 | First capture | 222152959 | Grasshopper Sparrow | RAGG | Yes | | | Adult | Male |
| 6/5/2015 | 377087 | 4238100 | First capture | 222152960 | Grasshopper Sparrow | LAGO | Yes | | | Adult | Male |
| 6/5/2015 | 377035 | 4238137 | First capture | 222152961 | Grasshopper Sparrow | YAOR | Yes | | | Adult | Male |
| 6/5/2015 | 375760 | 4239624 | First capture | 222152962 | Grasshopper Sparrow | None | | Yes | Yes | Adult | Male |
| 6/5/2015 | 375768 | 4239567 | First capture | 222152963 | Grasshopper Sparrow | GAOL | Yes | | | Adult | Male |
| 6/5/2015 | 375650 | 4239580 | First capture | 222152964 | Grasshopper Sparrow | KAWO | Yes | | | Adult | Male |
| 6/8/2015 | 375773 | 4239477 | First capture | 222152965 | Grasshopper Sparrow | None | | | Yes | Adult | Male |
| 6/8/2015 | 375780 | 4239387 | First capture | 222152966 | Grasshopper Sparrow | None | | Yes | Yes | Adult | Male |
| 6/8/2015 | 375780 | 4239387 | First capture | 222152967 | Grasshopper Sparrow | KARO | Yes | | | Adult | Male |
| 6/8/2015 | 375872 | 4239290 | First capture | 222152968 | Grasshopper Sparrow | YAYY | Yes | | | Adult | Male |
| 6/8/2015 | 375872 | 4239290 | First capture | 222152969 | Grasshopper Sparrow | OARO | Yes | | | Adult | Male |
| 6/8/2015 | 375872 | 4239290 | First capture | 222152970 | Grasshopper Sparrow | RALG | Yes | | | Adult | Male |
| 6/8/2015 | 375943 | 4239260 | First capture | 222152971 | Grasshopper Sparrow | LAYR | Yes | | | Adult | Male |
| 6/8/2015 | 375988 | 4239403 | First capture | 222152972 | Grasshopper Sparrow | OAWG | Yes | | | Adult | Male |
| 6/8/2015 | 375988 | 4239403 | First capture | 222152973 | Grasshopper Sparrow | KAKY | Yes | | | Adult | Male |
| 6/8/2015 | 376008 | 4239640 | First capture | 222152974 | Grasshopper Sparrow | RALL | Yes | | | Adult | Male |
| 6/8/2015 | 375245 | 4239431 | First capture | 222152975 | Grasshopper Sparrow | OALO | Yes | | | Adult | Male |
| 6/8/2015 | 375150 | 4239397 | First capture | 222152976 | Grasshopper Sparrow | WALR | Yes | | | Adult | Male |
| 6/8/2015 | 375799 | 4240226 | First capture | 222152977 | Grasshopper Sparrow | KAKK | Yes | | | Adult | Male |
| 6/12/2015 | 375696 | 4240424 | First capture | 222152978 | Grasshopper Sparrow | None | | Yes | Yes | Adult | Male |
| 6/12/2015 | 375752 | 4240469 | First capture | 222152979 | Grasshopper Sparrow | None | | Yes | Yes | Adult | Male |
| 6/12/2015 | 375752 | 4240408 | First capture | 222152980 | Grasshopper Sparrow | None | | Yes | Yes | Adult | Male |
| 6/12/2015 | 375752 | 4240408 | First capture | 222152981 | Grasshopper Sparrow | None | | Yes | Yes | Adult | Male |
| 6/12/2015 | 375867 | 4240283 | First capture | 222152982 | Grasshopper Sparrow | None | | Yes | Yes | Adult | Male |
| 6/12/2015 | 375867 | 4240283 | First capture | 222152983 | Grasshopper Sparrow | None | | Yes | Yes | Adult | Male |

Appendix A: Banding data for PAX (June, 2015)

| Capture date | UTMS Easting zone 18 | UTMS Northing zone 18 | Disposition | Band number | Species | Color band combo | Fitted with a geolocator? | Blood sampled? | Feather collected? | Age | Sex |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 6/12/2015 | 375786 | 4240175 | First capture | 222152984 | Grasshopper Sparrow | None | | Yes | Yes | Adult | Male |
| 6/12/2015 | 375735 | 4240195 | First capture | 222152985 | Grasshopper Sparrow | None | | Yes | Yes | Adult | Male |
| 6/12/2015 | 375733 | 4240251 | First capture | 222152986 | Grasshopper Sparrow | None | | Yes | Yes | Adult | Male |
| 6/16/2015 | 376766 | 4238055 | First capture | 222152987 | Grasshopper Sparrow | None | | Yes | Yes | Adult | Male |
| 6/16/2015 | 376766 | 4238055 | First capture | 222152988 | Grasshopper Sparrow | None | | Yes | Yes | Adult | Male |
| 6/16/2015 | 376809 | 4238051 | First capture | 222152989 | Grasshopper Sparrow | None | | Yes | Yes | Adult | Male |
| 6/16/2015 | 376648 | 4237759 | First capture | 222152990 | Grasshopper Sparrow | None | | Yes | Yes | Adult | Male |
| 6/16/2015 | 376648 | 4237759 | First capture | 222152991 | Grasshopper Sparrow | None | | Yes | Yes | Adult | Male |
| 6/16/2015 | 376751 | 4237694 | First capture | 222152992 | Grasshopper Sparrow | None | | Yes | Yes | Adult | Male |

Appendix B: Bird species reported to eBird for PAX (June, 2015)

| Species | Species |
|---|---|
| Canada Goose (Branta canadensis) | Prairie Warbler (Setophaga discolor) |
| Mallard (Anas platyrhynchos) | Yellow-breasted Chat (Icteria virens) |
| Wild Turkey (Meleagris gallopavo) | Eastern Towhee (Pipilo erythrophthalmus) |
| Great Blue Heron (Ardea herodias) | Field Sparrow (Spizella pusilla) |
| Great Egret (Ardea alba) | Grasshopper Sparrow (Ammodramus savannarum) |
| Green Heron (Butorides virescens) | Song Sparrow (Melospiza melodia) |
| Glossy Ibis (Plegadis falcinellus) | Northern Cardinal (Cardinalis cardinalis) |
| Black Vulture (Coragyps atratus) | Blue Grosbeak (Passerina caerulea) |
| Turkey Vulture (Cathartes aura) | Indigo Bunting (Passerina cyanea) |
| Osprey (Pandion haliaetus) | Dickcissel (Spiza americana) |
| Bald Eagle (Haliaeetus leucocephalus) | Red-winged Blackbird (Agelaius phoeniceus) |
| Cooper's Hawk (Accipiter cooperii) | Eastern Meadowlark (Sturnella magna) |
| Red-shouldered Hawk (Buteo lineatus) | Common Grackle (Quiscalus quiscula) |
| Broad-winged Hawk (Buteo platypterus) | Baltimore Oriole (Icterus galbula) |
| Red-tailed Hawk (Buteo jamaicensis) | House Finch (Haemorhous mexicanus) |
| Killdeer (Charadrius vociferus) | American Goldfinch (Spinus tristis) |
| Herring Gull (Larus argentatus) | |
| Common Tern (Sterna hirundo) | |
| Rock Pigeon (Columba livia) | |
| Mourning Dove (Zenaida macroura) | |
| Yellow-billed Cuckoo (Coccyzus americanus) | |
| Chimney Swift (Chaetura pelagica) | |
| Ruby-throated Hummingbird (Archilochus colubris) | |
| Red-headed Woodpecker (Melanerpes erythrocephalus) | |
| Red-bellied Woodpecker (Melanerpes carolinus) | |
| Northern Flicker (Colaptes auratus) | |
| Great Crested Flycatcher (Myiarchus crinitus) | |
| Blue Jay (Cyanocitta cristata) | |
| American Crow (Corvus brachyrhynchos) | |
| crow sp. (Corvus spp.) | |
| Fish Crow (Corvus ossifragus) | |
| Horned Lark (Eremophila alpestris) | |
| Purple Martin (Progne subis) | |
| Tree Swallow (Tachycineta bicolor) | |
| Barn Swallow (Hirundo rustica) | |
| Tufted Titmouse (Baeolophus bicolor) | |
| Carolina Wren (Thryothorus ludovicianus) | |
| American Robin (Turdus migratorius) | |
| Gray Catbird (Dumetella carolinensis) | |
| Brown Thrasher (Toxostoma rufum) | |
| Northern Mockingbird (Mimus polyglottos) | |
| European Starling (Sturnus vulgaris) | |
| Cedar Waxwing (Bombycilla cedrorum) | |
| Common Yellowthroat (Geothlypis trichas) | |

Appendix C: Point count data summary for PAX (June, 2015)

| Species | Individuals detected | Detection rate (%) |
|---|---|---|
| Canada Goose (Branta canadensis) | 9 | 5.3 |
| Great Blue Heron (Ardea herodias) | 1 | 2.6 |
| Turkey Vulture (Cathartes aura) | 5 | 10.5 |
| Osprey (Pandion haliaetus) | 10 | 7.9 |
| Bald Eagle (Haliaeetus leucocephalus) | 3 | 5.3 |
| Red-tailed Hawk (Buteo jamaicensis) | 1 | 5.3 |
| Killdeer (Charadrius vociferus) | 3 | 5.3 |
| Herring Gull (Larus argentatus) | 1 | 2.6 |
| Rock Pigeon (Columba livia) | 27 | 15.8 |
| Mourning Dove (Zenaida macroura) | 3 | 7.9 |
| Chimney Swift (Chaetura pelagica) | 5 | 10.5 |
| Northern Flicker (Colaptes auratus) | 2 | 2.6 |
| Red-bellied Woodpecker (Melanerpes carolinus) | 1 | 2.6 |
| Great Crested Flycatcher (Myiarchus crinitus) | 1 | 2.6 |
| Blue Jay (Cyanocitta cristata) | 9 | 15.8 |
| American Crow (Corvus brachyrhynchos) | 67 | 71.1 |
| Fish Crow (Corvus ossifragus) | 1 | 5.3 |
| Horned Lark (Eremophila alpestris) | 3 | 15.8 |
| Tree Swallow (Tachycineta bicolor) | 3 | 5.3 |
| Barn Swallow (Hirundo rustica) | 31 | 23.7 |
| Carolina Wren (Thryothorus ludovicianus) | 2 | 5.3 |
| American Robin (Turdus migratorius) | 1 | 2.6 |
| Gray Catbird (Dumetella carolinensis) | 34 | 39.5 |
| Brown Thrasher (Toxostoma rufum) | 12 | 18.4 |
| Northern Mockingbird (Mimus polyglottos) | 13 | 26.3 |
| European Starling (Sturnus vulgaris) | 141 | 39.5 |
| Common Yellowthroat (Geothlypis trichas) | 33 | 50.0 |
| Prairie Warbler (Setophaga discolor) | 19 | 39.5 |
| Yellow-breasted Chat (Icteria virens) | 13 | 21.1 |
| Eastern Towhee (Pipilo erythrophthalmus) | 6 | 15.8 |
| Field Sparrow (Spizella pusilla) | 20 | 31.6 |
| Grasshopper Sparrow (Ammodramus savannarum) | 103 | 94.7 |
| Song Sparrow (Melospiza melodia) | 5 | 7.9 |
| Northern Cardinal (Cardinalis cardinalis) | 9 | 10.5 |
| Blue Grosbeak (Passerina caerulea) | 9 | 13.2 |
| Indigo Bunting (Passerina cyanea) | 24 | 44.7 |
| Dickcissel (Spiza americana) | 1 | 2.6 |
| Red-winged Blackbird (Agelaius phoeniceus) | 72 | 63.2 |
| Eastern Meadowlark (Sturnella magna) | 22 | 28.9 |
| Common Grackle (Quiscalus quiscula) | 52 | 28.9 |
| Baltimore Oriole (Icterus galbula) | 4 | 7.9 |
| American Goldfinch (Spinus tristis) | 20 | 15.8 |